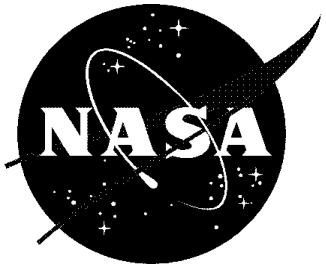

INTERNAL STUDY

POTENTIAL PATHFINDER AREAS FOR COMMERCIAL DEVELOPMENT OF THE INTERNATIONAL SPACE STATION

Discussion Draft

October 1998

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Introduction

An internal study was undertaken to identify pathfinder business enterprises with the potential to illuminate the commercial development of the International Space Station (ISS) and break down any perceived barriers to such development. The process used to identify opportunities for commercialization, as well as potential pathfinders to evaluate these opportunities is shown in Figure 1 and described in this report.The study concentrated on delineating the scope of potential commercial opportunities associated with the ISS, as well as evaluating, from the NASA perspective, several pathfinder areas of potential interest to the private sector. The NASA approach, evaluation criteria, and results are provided in the following study report. As the plan for commercial development proceeds, it is anticipated that new business concepts will emerge and move to the forefront as private industry becomes involved. These concepts may be related to the pathfinders identified in this study, or they may represent entirely new and innovative space products or services. In either case, NASA intends to proceed with the most effective set, as determined by the new Government-industry partnership.

Figure 1: Process Description

II. International Space Station Commercial Opportunities

A. Scope of Commercial Opportunity

The ISS has three broad categories of commercial opportunity: (1) users; (2) operations, and; (3) new capability development (Figure 2). With each of these areas, NASA is using its position as both a customer and a service provider to stimulate new commercial space businesses. As the user base broadens, it is expected that NASA will become just one of the customers for commercial operations and new capabilities.

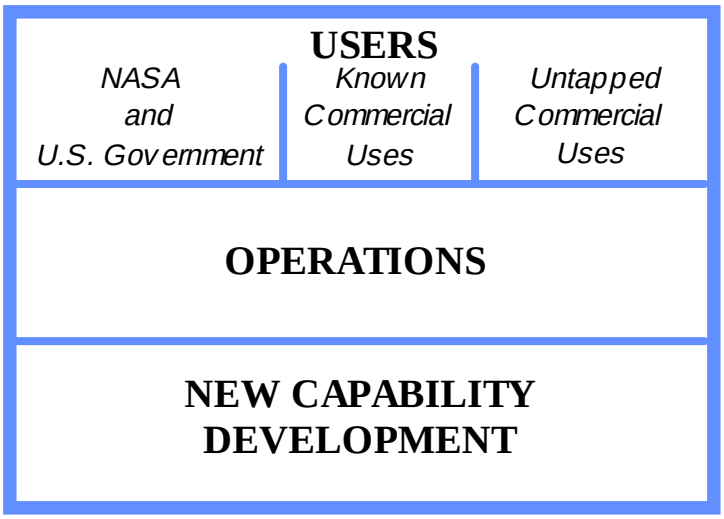

Figure 2: Scope of Commercial Opportunities

Users

NASA provides resources geared toward the unique capabilities and vantage point of the Station. The ISS will be an orbiting laboratory that will provide an unprecedented facility for long-term scientific research, technology development, and the achievement of commercial goals in the environment of space. To this end, the ISS has a variety of laboratory facilities available. These accommodations and services range from laboratory racks in pressurized modules, with full utility and crew services, to externally mounted attached payload sites that are exposed to the near vacuum of space. There are also viewing windows for observation.

The spectrum of ISS uses will broaden as the program evolves. For example, there are currently two proprietary users, which represent non-aerospace companies, with interests in using the ISS as a product development platform. In these cases the companies are pursuing ventures that are unprecedented in terms of willingness to invest private resources, as well as the diversity of their envisioned product lines.

As shown in Figure 3, there will be many new and previously untapped opportunities for using this unique facility once the ISS is deployed on orbit. To ensure that there will be adequate opportunities available for commercial uses, NASA has already committed to set aside at least 30 percent of the ISS's payload capacity for commercial development.

Operations

Private industry will provide the services necessary to maintain and continually improve ISS capabilities. Operating a space-based laboratory is different and far more complex than similar activities on Earth, but these are not insurmountable barriers for major U.S. service providers to overcome if they are to take their Earth-based services to space. The services needed for a research platform in low-Earth orbit are, in many cases, the same as are required anywhere on Earth or needed by the many satellites orbiting Earth. In the case of the Space Shuttle and the ISS-*Mir* programs, logistics support for both operations and the research community are already commercially provided.

The growing base of users will shape the future operational needs of the ISS. Commercial sources will provide and evolve these operational capabilities. NASA will become one of a number of paying customers for these augmented services. Candidates for ISS cover a wide range of opportunities, as encompassed in Figure 3.

New Capability Development

The commercial sector can provide capital improvements to the ISS based on the demand of both public and private customers. Such new capability development can be either enhancements to existing capabilities—for example, increasing the available power to the ISS users with commercially supplied power—or it can be a new capability—for example, a commercially provided module. Because of the large investment cost, this area represents the highest commitment of private funds. As with operations, new capability development will be market-driven by the profitability of the ISS uses and the increased demand. NASA, as one of many users, will benefit from these new and improved capabilities without bearing the burden of the total development cost.

B. Potential Pathfinder Commercial Opportunities

NASA inventoried ISS capabilities, facilities, and services to identify the areas that may represent commercial opportunities within each of the three major categories: (1) users; (2) operations, and; (3) new capability development. To this was added our past experience with research activities, the experience with each NASA Commercial Space Center (CSC), our discussions with industry, and insight from prior proposals received. We intend to continue use of the CSCís and industry to further validate these opportunities in future updates to this plan.

As the ISS user base develops and new requirements are identified, NASA plans to use commercial providers to meet emerging needs. One area that exemplifies this is the ISS Product Improvement Project, which identifies the requirements for upgrades, as well as determines whether they can be provided by commercial products or services. On July 31, 1998, six public announcements were issued to identify companies interested in participating in ISS Product Improvements.

A primary source for identifying commercial opportunities has been and will continue to be the CSCís, along with their many ties to industry and academia. The CSCís are, by charter, breeding grounds for new commercial ventures and, as such, serve as excellent sources for finding high-potential commercial candidates.

Finally, from time to time, NASA receives unsolicited commercial proposals from companies and individuals offering their products or services to NASA. This avenue of development is expected to continue, and NASA intends to reengineer internal processes for streamlining the dissemination of unsolicited proposals across the Agency.

Seeking new opportunities for commercial development is a continuous process. NASA has completed an initial search, and Figure 2 summarizes the range of potential commercial opportunities identified to date. The next step is for industry to perform a similar process to validate and enhance our results.

Users	***Operations***	***New Capability Development***
Pharmaceuticals	Mission Planning	Augmentation: Core Resources
Biotechnology	Training	Augmentation: New Resources
Materials	Flight Control	Additional Modules and Elements
Electronics/Photonics	Ground Processing	Free Flyers
Communications	Logistics, Repair, and Maintenance	Technology Development
Remote Sensing	Transportation	
Agriculture	Crew and Cargo Delivery/Return	
Imagery	On-Orbit Utilities (e.g., Space-to-Ground Communications,	
Education	Maintenance Engineering,	
Entertainment	Design Support to Customers,	
Advertisement (e.g., PBS Model)	Problem Resolution)	
Space Technology Testbed		
Manufacturing		

Figure 3: Potential Commercial Opportunities

C. Assessment and Selection of Potential Pathfinders

In order to assess and select candidate pathfinder commercial opportunities, NASA developed a set of evaluation factors and rating criteria. The following figures show the rating criteria and method used for identifying pathfinder cases. Figure 4 contains a brief explanation of the rating criteria, followed by a more detailed explanations of the criteria. Figure 5 is a tabulation of the preliminary ratings for each of the initial commercial opportunities. Figure 6 demonstrates the method for comparing and ranking the candidate opportunities by focusing on the high-potential, low-risk, and minimum barrier characteristics.

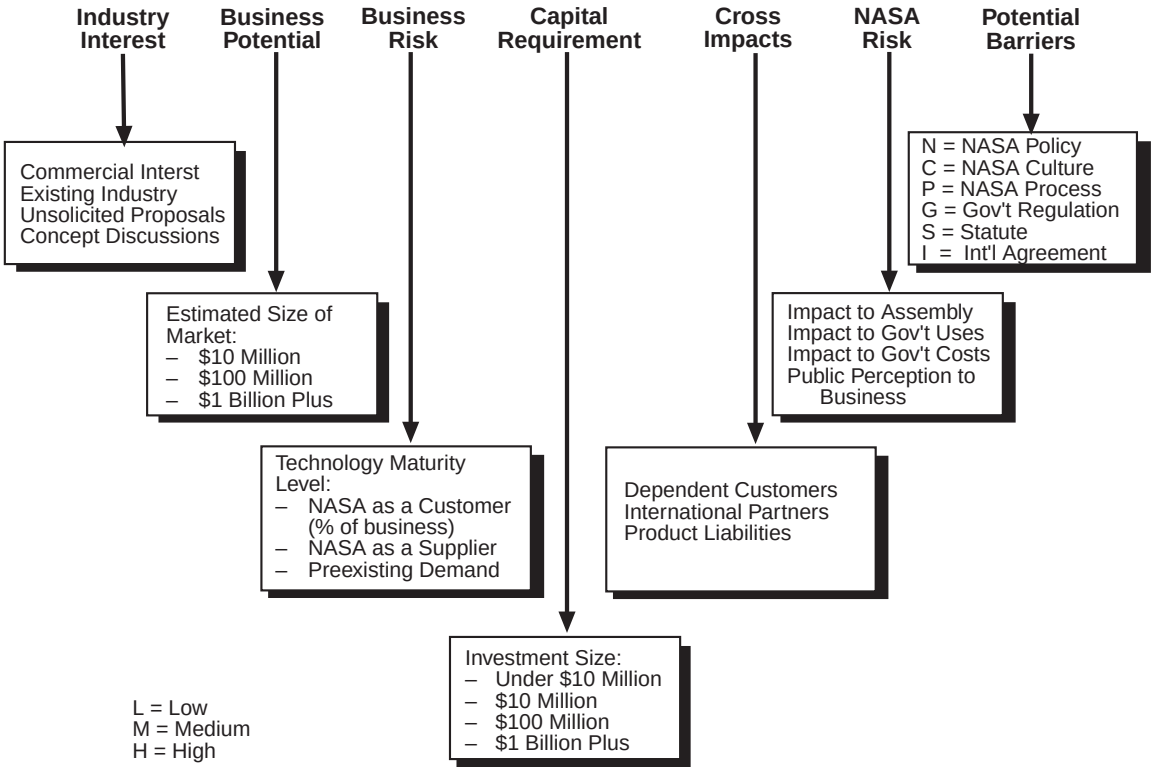

Figure 4: Preliminary Rating Criteria

Industry Interest

The first criterion used to evaluate each opportunity is the perceived commercial interest in developing a business in this area. The rating assigned is based on several factors:

- Is there an existing industry operating in this field?
- Has NASA received many unsolicited proposals?
- Have there been many concept discussions with businesses or individuals seeking to start a new business?

Business Potential

The business potential criterion estimates of the size of the potential market for the product or service. This estimate was based on such considerations as the cost and market size of similar items currently available either in the United States or elsewhere or the item's impact on another industry (for example, protein crystal growth has the potential to be the foundation for new drug development, thus adding value beyond the initial value of space-grown crystals).

The rating for an estimated market size of $100 million or less annually is Low, $100 million to $1 billion is Medium, and over $1 billion is High.

Business Risk

NASA has performed an initial assessment of the business risk associated with each of the opportunities based on several subjective characteristics. The Agency considered the maturity level of the technologies required for each opportunity and rated them on a technology readiness scale used for many other NASA projects. An evaluation was made of the expected percentage of the business that NASA demand would represent and whether there was preexisting demand for the product or service. Finally, an estimate of the lead time required to bring the product to commercial viability was factored into the overall rating of Low, Medium, or High.

Capital Requirement

The capital requirement, or investment size, estimate was based on NASA experience in developing new projects involving the development of space flight hardware.

The rating for an estimated investment size of $100 million or less annually is Low, $100 million to $1 billion is Medium and over $1 billion is High.

Cross Impacts

This criterion assesses the impact of implementing the commercial opportunity on other activities or groups. Specifically, it asks the following questions:

- Does this activity have any effect, either positive or negative, on the ISS international partners?
- Does this activity have any effect, either positive or negative, on other future customers of the ISS?
- Does this activity have any effect, either positive or negative, on other ISS participants? (For example, does it add power to the overall ISS capability, or does it use so much that it affects other users?)
- Does implementing this business create other business opportunities?

This criterion gets a subjective rating of Low, Medium, or High.

NASA Risk

Each opportunity implemented bears risk for the company starting in the new business area and for NASA. If the new endeavor has the potential to delay or accelerate the ISS assembly schedule, it would receive a negative or positive rating, respectively. Therefore, it is one of the most heavily weighted factors. Other questions entering into the overall rating for this category are:

- How much money must the Government invest in this venture, and how much would be nonrecoverable in case of failure?

- Could this cause the Government to lose other revenue (opportunity cost)?

- What is the expected public perception of this activity?

Potential Barriers

Barriers today can be turned into enablers or motivators tomorrow. Some barriers are easier to change than others. Some can be changed by actions taken within NASA; others require legislation and therefore are more difficult and take longer. By examining the potential barriers to each of the opportunities, NASA identified who controls the barrier and assessed the difficulty to overcome.

Specifically, the opportunities were scrutinized for: NASA policy, NASA culture, NASA processes, Government regulations, U.S. statutes, and international agreements. The types of barriers and the level of difficulty they present (Low, Medium, or High) were then noted in the analysis and entered into the decision of prioritizing opportunities.

		Example Opportunities	Indus. Int.	Bus. Pot.	Bus. Risk	Cap. Rqmt.	Cross Imp.	NASA Risk	Pot. Barr.
		Aeronautics							
		Space Science							
NASA		Earth Science							
		Life/Microgravity Sciences							
		Space Flight Systems							
	1.1	Pharmaceuticals	H	H	M	M	L	L	L/P
	1.2	Biotechnologies	M	M	L	M	L	L	L/P
	1.3	Materials	M	M	L	M	M	L	L/P
	1.4	Electronic/Photonics	M	H	M	M	M	L	L/P
	1.5	Nonelectronic	M	H	M	M	L	L	L/P
Known	1.6	Communications	H	H	L	M	M	M	M/C
Comm.	1.7	Remote Sensing	M	M	L	M	M	L	M/T, G
Uses	1.8	Agriculture	M	M	L	M	L	L	M/T, G
	1.9	Imagery	M	M	L	L	L	L	L-M/C
	1.10	Education	M	M	M	L	L	L	L/C
	1.11	Entertainment	H	H	M	M	M	L	M/N, C
	1.12	Advertising	H	H	L	M	M	M	H/ N, C
	1.13	Space Tech. Testbed	M	M	M	M	M	L	M/T, C
	1.14	Manufacturing	L	M	H	H	M	M	H/P
Un-known	2.0								
	3.1	Mission Planning	L	L	M	L	L	L	L/C
	3.2	Training	M	M	M	M	M	M	M/C
	3.3	Flight Control	M	M	M	M	M	M	M/C
	3.4	Ground Processing	M	M	L	M	M	M	L
	3.5	Logistics/Repair and Maintenance	M	M	M	M	M	M	M/C
Ops. Svcs.	3.6	Transportation	M	M	H	H	M	M	M/C, S, G
	3.7	Crew/Payload Return Vehicles	M	M	M	H	M	M	M/T, C
	3.8	On-Orbit Resources	H	H	M	M	M	M	M/T, C
	3.9	Maintenance Engineering	L	L	L	L	M	M	M/C
	3.10	Design Support to Customers	L	L	M	L	L	M	L/C
	3.11	Problem Resolution	L	L	M	L	M	M	M/C
	4.1	Augmentation: Core Resources	M	H	M	L	L	L	L/T, I
New Cap.	4.2	Augmentation: New Resources	H	H	H	M	M	M	M/T, I
Dev.	4.3	Add. Modules/Elements	M	M	M	M	M	L	M/T
	4.4	Free Flyers	M	M	M	M	M	M	M/C, T

Figure 5: Preliminary Ratings

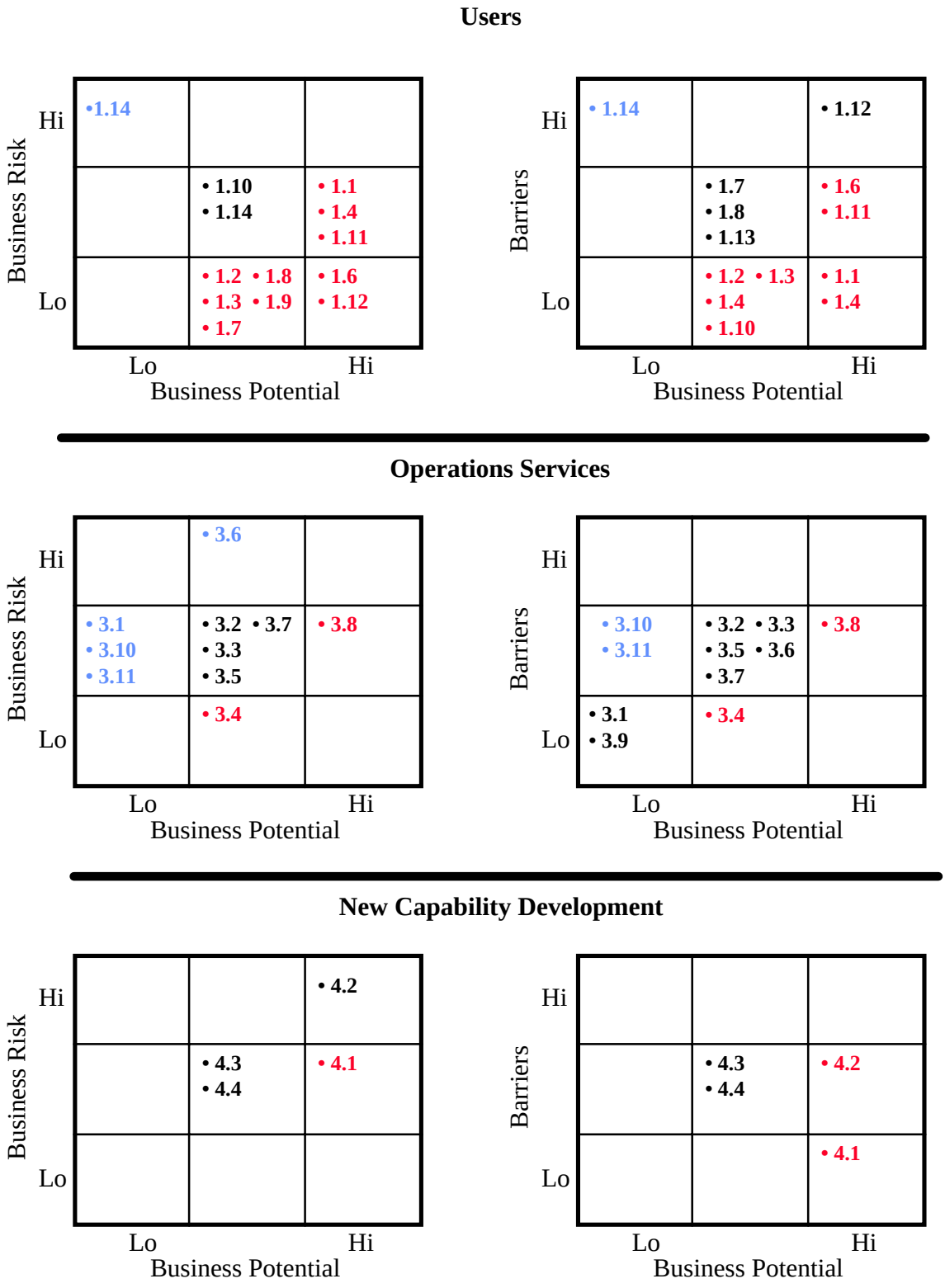

Figure 6: Preliminary Evaluation Methodology

III. Pathfinder International Space Station Commercial Opportunities

Each pathfinder has been selected specifically to demonstrate NASA's ability to satisfy commercial interests, to ìpush the envelopeî in the way NASA currently does business, and to enhance the probability of success. The initial set is listed below.

Uses:
- Consumer Goods in Space
- Brand Name Public Service Sponsorships
- Educational Products
- Payload Accommodations Auction
- New Product Development (Proprietary)
- On-Orbit Research Facility (Proprietary)

Operations:
- Imagery

New Capability Development:
- Communications
- Ground Operations Facility (Proprietary)

NASA is currently evaluating several proprietary proposals, as indicated above, which will be pursued in parallel with the other pathfinder cases. NASA is also using these proprietary cases to improve its handling of incoming unsolicited commercial proposals and proprietary data.

A. Non-Proprietary Pathfinders

Potential Pathfinder: *Commercial Communications*

Description
Several commercial groups have received licenses for an allocated spectrum in the broadband region (Ku and Ka bands) based on concepts to develop systems that include satellites and would provide worldwide, continuous coverage. Their target markets are both businesses and individuals. The ISS would augment ISS communications capabilities, at about 2002 or beyond, using these new space-based systems on a purely commercial basis.

Long-Term Objectives
Provide greater communications services to support users and ISS operations at acceptable, market-based prices. Utilize commercial service providers to meet ISS needs. Reduce ISS operational costs. Further stimulate in-space commercial communications providers.

Boundaries Pushed
NASA use of commercial service on orbit is novel and will help promote NASA culture, procurement, and technology. The ISS design will likely require designed-in and built-in capabilities to enable the future use of new commercial communications systems.

Strategy
Review new communications systems capabilities. Define specific ISS communications requirements. Identify legal, policy, and procurement steps to be taken. Identify and make technical changes required by the ISS and commercial system (at vendor option) to enable service provision. Procure service on a commercial basis.

Commercial Interests Identified
NASA has initiated discussions with several potential service providers to determine the level of service each plans to make available and the compatibility of their systems with the current ISS design.

Potential Pathfinder: *Brand Names in Public Service Sponsorship (PBS Model)*

Category: ***Users***

Description
Using the Space Shuttle as a precursor to the ISS, NASA should demonstrate the potential for public service sponsorships of key elements, such as flight equipment (for example, cameras) or services (for example, food and beverages), by nonaerospace companies. The model to be followed is aligned with that of the Public Broadcasting System, in which sponsorship is low key and tastefully done.

Long-Term Objectives
Allow opportunities for industry to generate marketing benefits in space while providing meaningful public services. Potentially offset NASA costs. Increase public exposure to the Space Shuttle.

Boundaries Pushed
This should broaden NASAís range of acceptable uses of the Shuttle. Innovative procurement mechanisms may be required, as well as the partial recovery of Space Shuttle operating costs in return for industry opportunities.

Strategy
Identify legal, policy, and procurement steps to be taken, including reassessing NASA limitations on promotional uses of the Shuttle. Evaluate the potential effect on the public's perception of NASA, and determine parameters of acceptable brand name displays and methods. With industry, evaluate the potential scope using market studies. Implement the pathfinder with a near-term flight opportunity.

Potential Pathfinder: *Consumer Goods in Space*

Category: ***Users***

Description
NASA should demonstrate the potential for industry to create added value and generate revenue from the transport of consumer goods to and from space without adversely affecting safety or public perception and at no marginal cost to NASA. Private goods might include memorabilia, honoraria, or educational products that would be transported on the Space Shuttle to the ISS and returned to Earth for sale.

Long-Term Objectives
Expand opportunities for industry to generate revenue in space, creating new markets. Potentially offset NASA costs. Increase public exposure to the Space Shuttle and the ISS.

Boundaries Pushed
This should broaden NASAís range of acceptable uses of the Shuttle and the ISS. Innovative procurement mechanisms may be required. The potential recovery of operating costs in return for opportunities to fly on the Shuttle and the ISS should be explored.

Strategy
Identify legal, policy, and procurement steps to be taken, including reassessing NASA limitations on the transport of goods on the Shuttle or the ISS. Evaluate the potential effect on the public's perception of NASA, and determine parameters of acceptable goods to be transported. With industry, evaluate the potential scope using market studies. Implement the pathfinder with a near-term flight opportunity.

Commercial Interests Identified
Numerous companies have contacted NASA. Most recently, Spacehab has expressed a desire to broaden the range of goods that is carried to orbit in Spacehab modules.

Potential Pathfinder: *Payload Accommodations Auction*

Category: ***Users***

Description
NASA should authorize *auctions* for Space Shuttle and ISS accommodation and resource bundles that correspond to fully functional flight opportunities for one internal pressurized payload site and one external attached payload site. Government constraints on use should be limited to safety and standard payload integration practices.

Long-Term Objectives
Establish private perception of value and magnitude of demand for ISS accommodations in an open market, as free as possible of Government distortion. Employ the results to develop a value-based pricing policy with clear subsidization levels. Using a value-based price can stimulate the creation of new industries, markets, and innovations.

Boundaries Pushed
The auctioning of access to space will likely require advances in policy, procurement, and potentially legislation. In addition, using auctions to provide full ownership to industry will advance NASAís organizational, procedural, and cultural approach to working with industry.

Strategy
Identify legal, policy, and procurement steps required to establish auctions. Fully define resource bundles to be auctioned and specific auction terms, such as duration and minimum bids. Consider auction periods of 2 years to periodically reassess value and demand. Define Government constraints, limited to safety and standard payload integration practices.

Potential Pathfinder: *Imagery*

Category: ***Operations***

Description
By the year 2000, the ISS will return to Earth more imagery in the form of video each day than most local television stations provide. By obtaining commercial sponsorship of selected portions of the video stream, NASA may achieve several goals, including commercialization, wider dissemination of ISS information to the public, and recovery of Government costs.

Long-Term Objectives

Determine the market value of the general downlink imagery aboard the ISS, with the objective of stimulating the creation of new markets. Increase the dissemination and use of such video. Enhance ISS video capture and downlink capabilities, and potentially offset NASA costs.

Boundaries Pushed
The use of commercial sponsorship would be a departure from traditional Federal Government approaches. Policy and procurement boundaries must be advanced. NASA will need to learn how to work with sponsors in a way that meets both NASA and industry goals.

Strategy
Identify policies required to be changed. Define imagery to be reserved for commercial use, and define acceptable uses. Via an open and fair competition, seek, review, and select corporate sponsorship offers. Such sponsorship would include a barter arrangement, in which the commercial firm would receive use of the video (and the right to put its name brand on some of the imagery) in exchange for services or products (such as imagery equipment) provided by the company to the ISS. The privacy rights of the crew, international partners, and scientific and commercial researchers will need to be protected.

Potential Pathfinder: *In-Space Educational Experiments*

Category: ***Users***

Description
NASA will seek to expand the Government-industry partnership to provide an in-space educational experiment program for students and educators. This initiative seeks to help NASA meet its educational goals in a commercial manner, with reduced costs, and supports the development of a commercial space educational service.

Long-Term Objectives
Support NASAís educational programs. Stimulate the development of a commercial educational service program.

Boundaries Pushed
Policy and procurement boundaries will need to be advanced. NASA and industry will need to learn how to work together to meet shared educational goals, particularly in meeting the rigors of educational requirements (such as national standards) in developing an in-flight program.

Strategy
Define industriesí educational service goals and NASA educational needs. Identify the policies required to be changed. Establish a procurement mechanism. Define and negotiate cost allocations between NASA and the company, such as costs to design and fly the experiment and to develop the educational elements of the program.

Commercial Interests Identified
A NASA CSC, the Microgravity Automation Technology Center, and the Spacehab corporation have already initiated the *S*T*A*R*S* program for student education through space experiment involvement. This could form the basis for this pathfinder.

B. Proprietary Pathfinders

The following are brief descriptions of commercial cases in which industry has initiated discussions with NASA. Each of these cases is serving as a pathfinder to help NASA create an improved environment for serving commercial needs. The details of these cases cannot be revealed because of their proprietary nature.

Case 1—User Category

A company provides an on-orbit research facility in exchange for the ability to market a share of the capability. NASA receives rights to a share of the capability. The company desires a corporate astronaut as part of package. *Status:* Under negotiation.

Case 2—User Category

A company has developed a systematic method for identifying high-potential commercial opportunities for scientific uses of the ISS. *Status:* Initial opportunities identified, and feasibility studies under way with NASA technical support.

Case 3—New Capability Development Category

A company provides ground facilities and services to NASA and other users. This eliminates the need for NASA to build and maintain similar capabilities. *Status:* Proposal presented, and discussions under way.